

# Beam Test '99 Outline

May 27, 1999  
Gary Godfrey

## 1) Approval status:

Electrons	T435?	1 Month	(Nov 1 – Nov 30)
Protons	T436	1 Month	(Dec 1 - )

## 2) Goals

## 3) Runtime estimates for various tasks

## 4) ESA layout

## 5) XYθ table

## 6) DAQ network

## 7) DAQ software strategy

## 8) Beams

## 9) Particle ID

## 10) WBS

## 11) Schedule

# 1999 SLAC Beam Test

Summarized from Steve Ritz's note Feb 15, 1999 and Eric Grove's email.

## Goals

- 1) Test principles of DAQ and Trigger
- 2) Characterize system level noise
- 3) Flight software concepts test bed
- 4) Tracker  
    PSF at larger angles of incidence than 1997
- 5) Calorim:  
    Map response along logs  
    Shower reconstruction for off axis tracks  
    Side entering response  
    Study dual photodiode and ASIC
- 6) Hadrons  
    Validate simulations – particularly in calorimeter  
    Study side entering hadrons
- 7) Neutrons  
    Measure fraction of plastic scint vetoes due to CsI shower neutrons
- 8) Superlast  
    Validate simulations for 2% and 20% radiators ?  
    Energy resolution at low energies

# Run Time Estimates

Map calorimeter response

2-10 Gev electrons

3 cm steps

(5,000 elec x 100 positions / (10 Hz x .35 effic)) = 1.7 days

Calorimeter off axis imaging

2-10 GeV electrons

(20,000 elec x 3 energies x 5 angles / (10 Hz x .35 effic)) = 1.0 days

Multi-electrons per pulse

Study calorim dynamic range

Study tracker 2 track resolution

(50,000 elec / (10 Hz x .20 effic)) = .3 days

Tracker Photons on axis

Desire 6000 photons, E>10 GeV (twice 1997 run)

~1 photon E>10 MeV / pulse implies .09 E>10 GeV

(6000 / ( 10 Hz x .35 effic x .09 x .35 conv x .25 clean)) = 2.5 days

Tracker Photons off axis

Desire 30,000 photons, E>1 GeV

(6000 x 5 angles / (10 x .35 x .39 x .35 x .25)) = 2.9 days

Protons

One or two weeks after electron and gamma runs = 7 days

.05 p/pulse x 10 Hz x 86,400 x 7 = 300,000 protons

Divided between normal and side incidence later

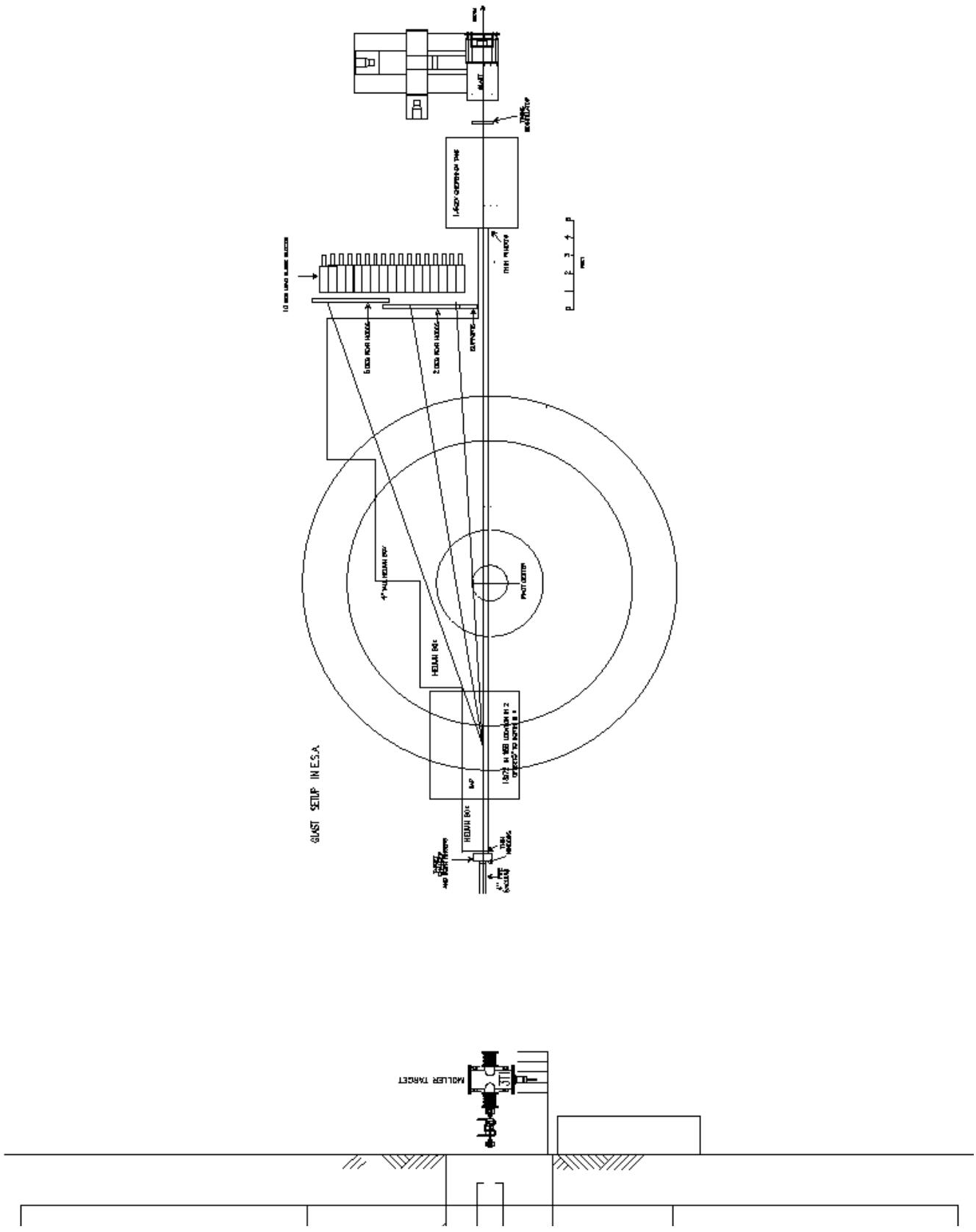
Total=      8.7 days electrons  
                7 days protons

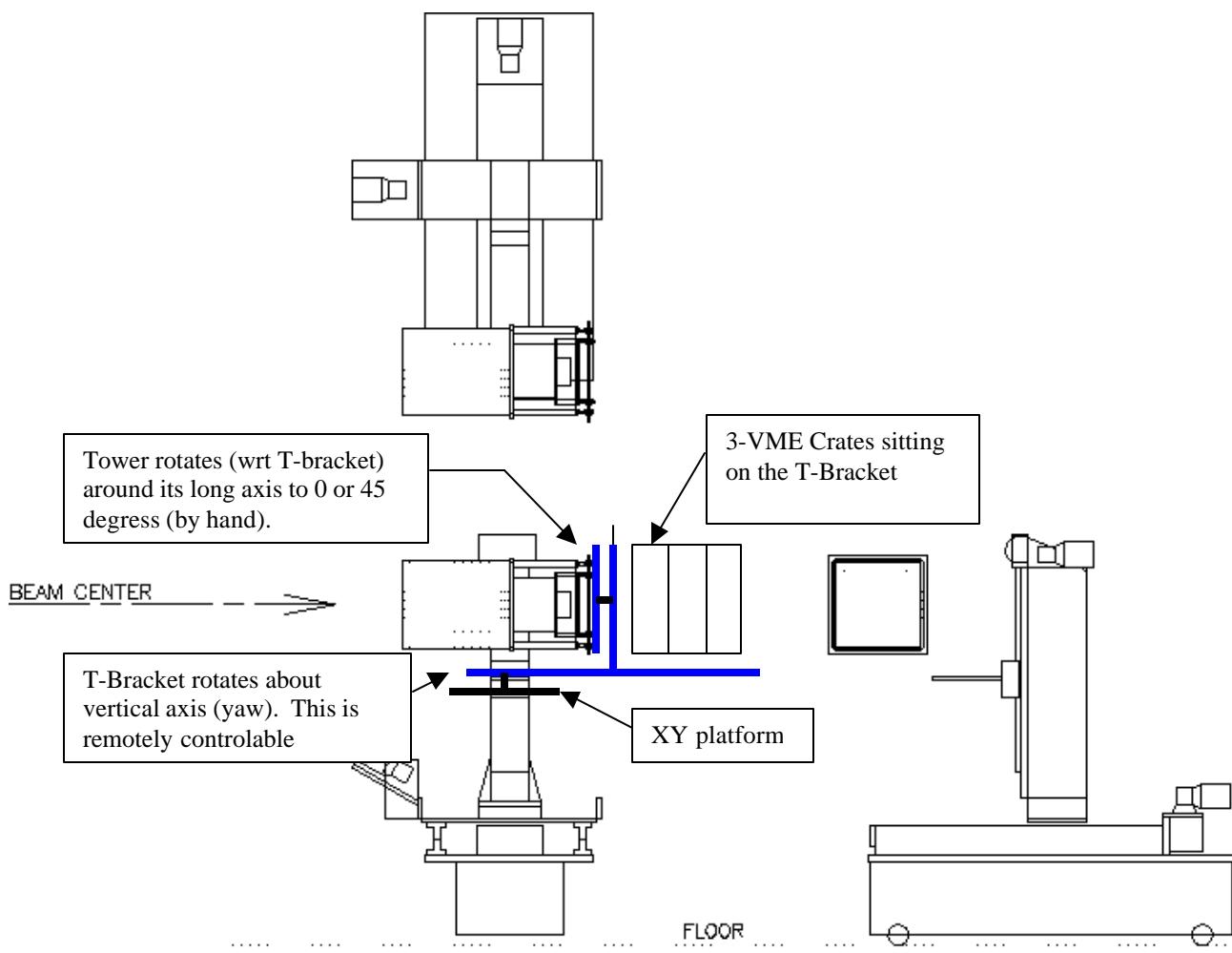
Accellerator duty cycle, setup time estimate x 3. Thus ~45 day run.

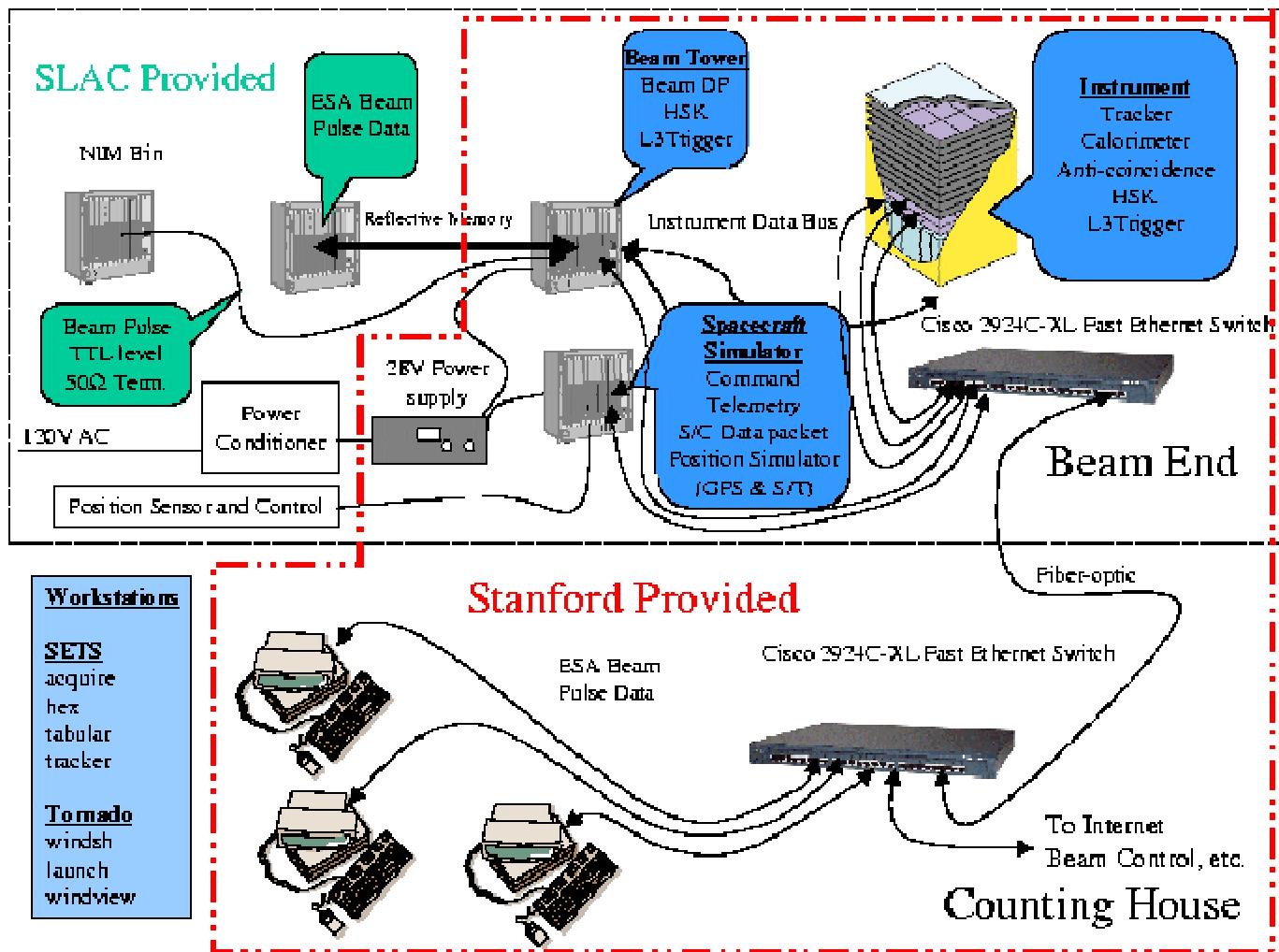
Have requested from SLAC: **1) Electrons**      **1 month (Nov)**  
**2) Protons, pi+**      **1 month ( Nov - Dec )**

Data Volume (recording every pulse):

(16 days)(86400 sec/day)(10 events/sec)(3000 bytes/event)= 41 Gbytes







## Software Strategy

- 1) ESA Vax DAQ freeruns, filling reflective mem every beam pulse.

No runs are started or stopped on ESA vax.

No messaging between Vax and Suns.

All ESA and Linac info flows through reflective memory.

- 2) Event is assembled in Tracker TEM CPU.

Tracker TEM CPU grabs info from other nodes on network.

- 3) Run is started and stopped in Sun.

All the DAQ does is transfer the raw assembled events from the Tracker TEM CPU to the Sun's disk.

- 4) Pieces of GLASTSIM analyze occassional events and makes n-tuple to disk (not an archival file, only several recent runs are saved).

PAW eats n-tuples from disk.

IDL eats n-tuples from disk.

- 5) Each subsystem gets its own raw calibration data to Sun's disk.

Either by:

- a) Runs with the normal DAQ, or
- b) Stand alone software that writes their own format files to disk.

- 6) When a run is started, every beam pulse is written to disk.

# Beam Parameters

## 1) Positron Beam

~ 1 GeV to 27 GeV

~ 0.1 to 10 e+/pulse

Spot Size: ~4 mm wide, 2 mm tall

Rep Rate: min 10 Hz, max 60 Hz

$\Delta E_{\text{positron}}/E_{\text{positron}}$ : ~ 1% FWHM

## 2) Photon Beam

~30 MeV to 20 GeV

~0.1  $\gamma$ /pulse (tagged)

Spot Size: same as positron beam for  $E_{\text{positron}} > 10 \text{ GeV}$ .

$\Delta E_{\gamma}$ : ~ 0.01 GeV mult scat (1% rad) and hodo ( $\sigma = 3 \text{ mm}$ )

+ 0.005  $E_{\text{positron}}$

(Pb glass resolution is only .08  $E_{\text{positron}}$ )

Magnet: 18D72

8" wide, 72" long, 6" gap

21 kG max (41 kG-m).

Deflection 1.24/E rad for  $E > 7 \text{ GeV}$ ,

fixed at 0.16 rad for  $E < 8 \text{ GeV}$  by lowering field

Detectors: plastic scint 3 cm wide x 2 overlapping layers

7.5 m from center of magnet

0.4 to 2.9 m transverse to beamline

17 Pb blocks (14.2 cm x 14.2 cm x 42 cm)

## 3) Hadron Beam

~ 2 GeV to 20 GeV

~ 1 hadron/pulse (5% protons)

Spot Size: ~4 mm wide, 2 mm tall

Rep Rate: min 10 Hz, max 60 Hz

$\Delta E_{\text{hadron}}/E_{\text{hadron}}$ : ~ 1% FWHM

For 3E10 e- on 0.3 r.l. Be at 0.5 deg, E0= 30.

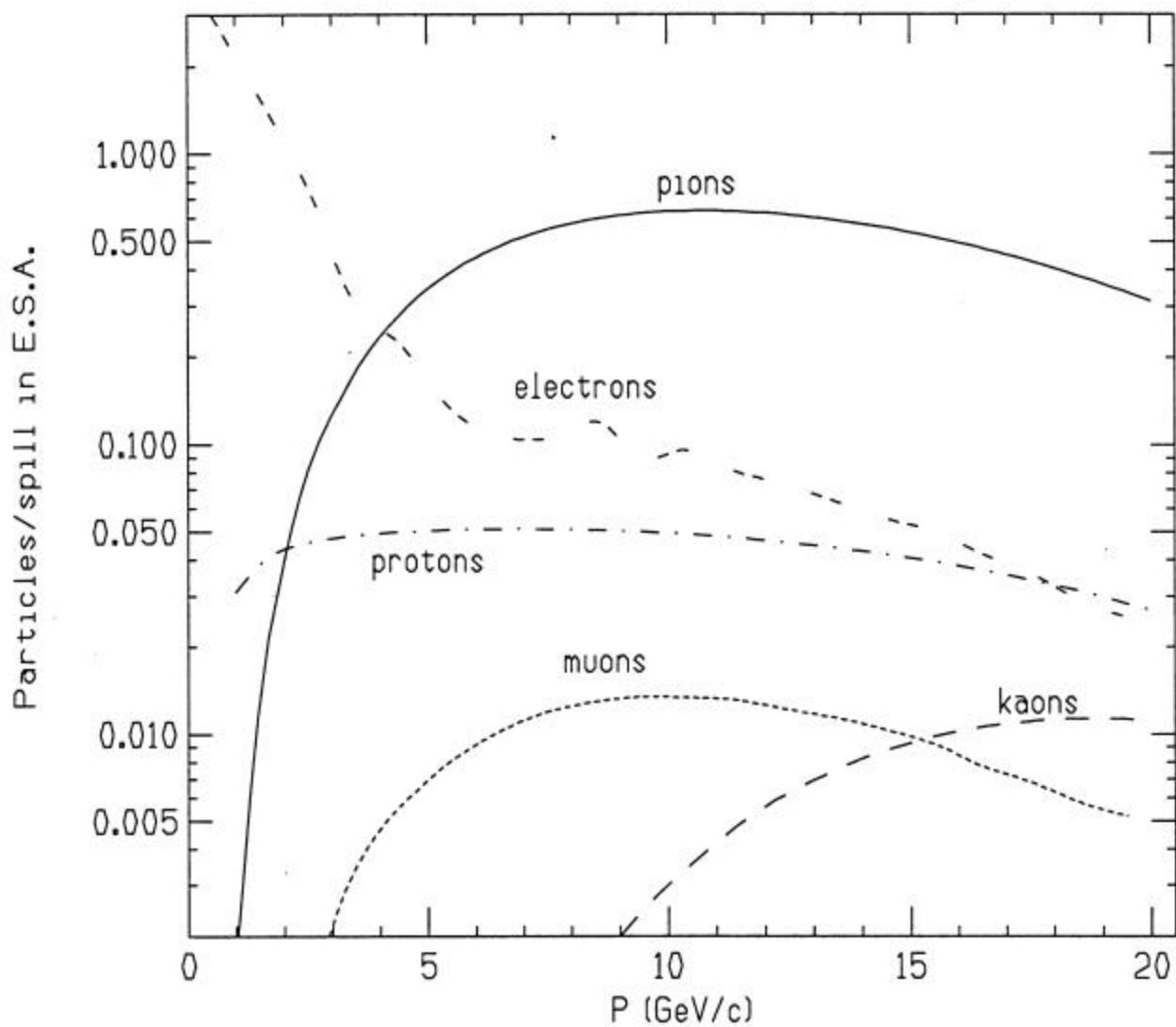


Figure 2. Predicted rate/spill in E.S.A. for pion, protons, and kaons, averaged over the three models shown in Fig. 1. Also shown are the predicted rates of positrons and muons.

**TOF Calculation**

i := 0 .. 3

$$c := 3 \cdot 10^8$$

[m/sec]

$m_i :=$

$$L := 336.5 - 56.8$$

[m]

.511
139.6
493.7
938.3

May 6, 1999

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d:\winmcad\glast\tof.mc

j := 0 .. 19

$$P_j := (j + 1) \cdot 1000.$$

[mev/c]

$$\text{tof}_{j,i} := \frac{L}{c \cdot \tanh \left( \text{asinh} \left( \frac{P_j}{m_i} \right) \right)}$$

$$\Delta \text{tof}_{j,i} := (\text{tof}_{j,i} - \text{tof}_{j,0}) \cdot 10^9$$

[nsec]

The tof difference between pi, k, p and e (in the 0 column) for various momenta is shown below:

[nsec]

	0	1	2	3
0	0	9.041	107.433	346.156
1	0	2.268	27.986	97.505
2	0	1.009	12.54	44.538
3	0	0.568	7.075	25.308
4	0	0.363	4.534	16.275
5	0	0.252	3.151	11.332
6	0	0.185	2.316	8.339
7	0	0.142	1.774	6.391
8	0	0.112	1.402	5.053
9	0	0.091	1.136	4.095
10	0	0.075	0.939	3.386
11	0	0.063	0.789	2.846
12	0	0.054	0.672	2.425
13	0	0.046	0.58	2.092
14	0	0.04	0.505	1.822
15	0	0.035	0.444	1.602
16	0	0.031	0.393	1.419
17	0	0.028	0.351	1.266
18	0	0.025	0.315	1.136
19	0	0.023	0.284	1.025

[Mev/c]

	0
0	1000
1	2000
2	3000
3	4000
4	5000
5	6000
6	7000
7	8000
8	9000
9	10000
10	11000
11	12000
12	13000
13	14000
14	15000
15	16000
16	17000
17	18000
18	19000
19	20000

$\Delta \text{tof} =$

## Threshold Cherenkov counter. CO<sub>2</sub>, 1atm, 1.5 meter

Pressure:= 1 [atm] n := 1 + .000410 · Pressure Length= 150 [cm]

$$\beta_{\text{thresh}} := \frac{1}{n}$$

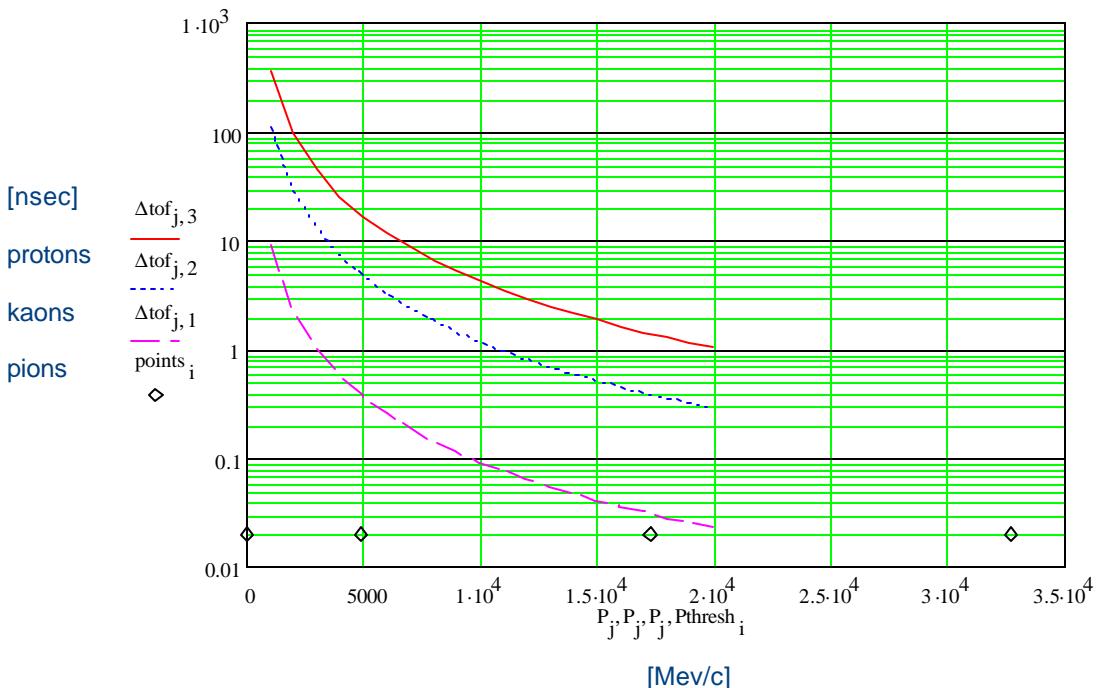
$$\beta\gamma_{\text{thresh}} := \sin(\text{atan}(\beta_{\text{thresh}}))$$

$$P_{\text{thresh}} := \beta\gamma_{\text{thresh}} m_i$$

	P <sub>thresh</sub> [MeV/c]	Number of photoelectrons when far above threshold (ie: Beta=
	P <sub>thresh</sub> =	N <sub>pe</sub> := Length90 · $\left[ 1 - \left( \frac{1}{n} \right)^2 \right]$
e	17.843	
pion	4.875 · 10 <sup>3</sup>	N <sub>pe</sub> = 11.063 [photoelectrons]
kaon	1.724 · 10 <sup>4</sup>	
proton	3.276 · 10 <sup>4</sup>	

points<sub>i</sub> := .02

TOF difference wrt electrons



e thresh      pion thresh      kaon thresh

.02 < P < 5 Gev/c pi,k,p do not work Cherenkov. Tell pi,k,p apart by TOF

5 < P < 17 Gev/c k,p do not work Cherenkov. Tell k,p apart by TOF (.8 ns p-k difference at 15 Ge

17 < P < 33 GeV/c p do not work Cherenkov.

**Beam Test '99**  
**WBS**

G.  
Godfrey  
Updated :  
24-May-99

	<b>Who</b>	<b>Sub-whc</b>
1. Beam time requests to SLAC	Ray Arnold	
1.1 Electrons (1month)		
1.2 Protons (1 month)		
2. ESA floor preparation	Richard Boyce	
2.1 Clear floor area		
2.2 Install clean AC power		
3. Tower XY table (refurbish existing table)	Richard Boyce	
3.1 T bracket mount for tower		
3.2 New XY motors		
3.3 Rotation (yaw) gearbox and motor		
3.4 X,Y,rotation readout potentiometers		
3.5 Motor control and readout box		
3.6 Power supplies		
3.7 Cables		
4. Beamline instrumentation procurement and installation	Ray Arnold	
4.1 Beam defining scintillators		
4.2 Photon tagger		
4.2.1 Radiator foil		
4.2.2 B0 magnet		
4.2.3 Scint hodoscope		
4.2.4 Pb blocks		
4.3 Helium box		
4.4 Cherenkov counter		
4.5 TOF		
4.5.1 Foam cables (3) from proton target to ESA		
4.5.2 PMT+HV at proton target		

5. Prototype tower construction		
5.1 Mechanical frame	Bruce Feerick	
5.2 Tracker	Robert Johnson	
5.3 Calorimeter	Neil Johnson	
5.4 ACD	Alex Mosiev	
6. Shower neutron detection	AI Odian	
6.1 NaI Scint and PMT		
6.2 Plastic Scint (thin) and PMT		
6.3 Plastic Scint (thick) and PMT		
6.4 Cables to ESA ADCs and HV		
7. DAQ hardware procurement and installation		
7.1 Suns		
7.1.1 GAMMA	Stanford	
7.1.2 GAMERA	Stanford	
7.1.3 GAMOW	SLAC	
7.1.4 Machine network security	Paul Kuntz	
7.2 Network	Dave Lauben	
7.2.1 Counting house to floor fiber		
7.2.2 Cisco switch (counting house)		
7.2.3 Cisco switch (ESA floor)		
7.2.4 Beam tower VME crate		
7.2.4.1 Reflective memory card		
7.2.5 Spacecraft simulator VME crate		
7.2.5.1 Slow ADC card		
7.2.6 Tracker TEM VME crate		
7.2.7 Calorimeter TEM VME crate		
7.2.8 ACD TEM crate		
8. DAQ Software development		
8.1 Tracker TEM	Bob Bumala	
8.2 Calorimeter TEM	Bob Bumala	
8.3 ACD TEM	Bob Bumala	
8.4 ESA load ref mem each beam pulse (free running)	Zen Szalata	
8.5 Beam tower VME cpu	Bob Bumala	
8.6 Spacecraft simulator VME cpu	Bob Bumala	
8.7 Run control in Sun	Dave Lauben	

8.8 Transfer event block from Tracker TEM to Sun disk	Dave Lauben
8.9 Adapt parts of GLASTSIM	Sawyer Gillespie
8.9.1 Generate n-tuple from raw event block	
8.9.2 Event display to screen	
8.10 Interface n-tuple to PAW	SLAC
8.11 Interface n-tuple to IDL	Goddard
8.12 Archive datafiles from disk to DLT	SLAC
8.13 Generate diskfile of simulated data	Sawyer Gillespie
9. Proton Target	Dieter Walz
9.1 Design	
9.2 Build	
9.3 Radiation Safety	Ray Arnold
9.3.1 Shielding calculations	
9.3.2 Radiation Safety Committee Approval	
9.4 Controls	Gerard Oxoby
9.4.1 Steering SEM	
9.4.2 Thermocouples	
10. Calibration DAQ and displays	
10.1 Tracker	Robert Johnson
10.2 Calorimeter	Neil Johnson
10.3 ACD	Alex Mosiev
10.4 Tagger	Peter Bosted
10.5 Shower neutron detector	Al Odian
11. Offline data analysis (after run)	

## Beam Test '99 Milestones

May 27, 1999  
Gary Godfrey

5/24 E155 done

EFD Begins cleaning ESA floor in GLAST area.

6/1 Stanford begins setting up Suns and network at ESA.  
Dieter Walz begins proton target design.

7/1 Stanford sends real TEM boards to UCSC, NRL, GSFC ?  
XYθ Table mods complete.  
Clean AC available at GLAST floor position.  
Tagger supports complete and in place on floor.

8/1 B0 in place  
Cherenkov tank in place and gas flowing.  
XYθ in place on floor and operational.

8/15 Tagger completely operational.

9/1 All software tasks complete.  
Begin install of proton target in BSY (PEPII just finished run).  
Begin install TOF target PMT + cabling complete  
Beam defining scintillators installation complete.  
Begin fitting in He box.

9/15 All equipment (Tracker, Calorimeter, ACD) is at SLAC.  
Tower+T-bracket is integrated/tested in the Clean Room.

10/1 Tower is installed on XYθ in ESA.  
Exercise the DAQ on cosmics.

11/1 Beam test begins (electrons), 12/1 Beam test begins (protons).